Seasonal Population Dynamics and Movement of GWSS in Sweet Orange (cv. 'Valencia') Trees Maintained Under Continuous Deficit Irrigation

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Dispersal and Movement of the Glassy-winged Sharpshooter and Associated Natural Enemies in a Continuous, Deficit-Irrigated Agricultural Landscape

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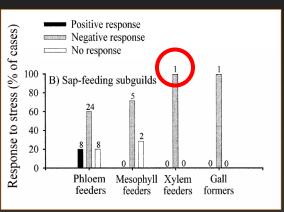
Role of plant water stress on regulation of insect population dynamics

- Plant Stress Hypothesis (White 1969, 1974, 1984).
 - Abiotic stress causes an increase in nitrogenous compounds in plants (White 1969, 1974, 1984; Mattson and Haack 1987)
 - Reduced concentrations of defensive chemicals (Rhoades 1979).
- Plant Vigor Hypothesis (Price 1991).
- Pulsed Stress Hypothesis (Huberty and Denno 2004).

Role of plant water stress on regulation of insect population dynamics

 Huberty and Denno (2004). Vote-counting and Metaanalysis on 116 studies (from 1955-2002).

"...strong negative effects of water stress on sap-feeders (phloem- and mesophyll-feeding guilds)."



Huberty and Denno. 2004. Plant water stress and its consequences for herbivorous insects: a new synthesis. Ecology 85: 1383-1398.

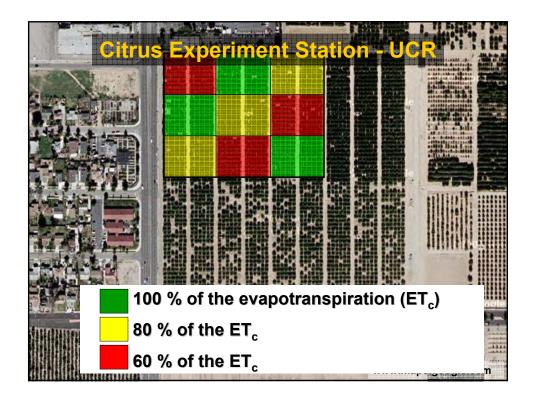
Role of regulated deficit irrigation (RDI) on citrus fruit quality, fruit size, and yield.

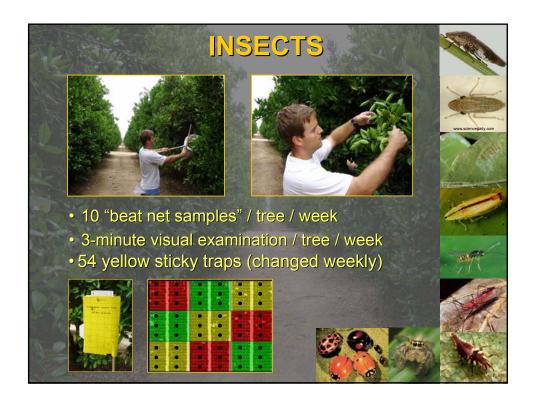
Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun

- No reduction in gross revenue with RDI in Navel orange trees in CA (Goldhamer and Salinas 2000).
- No reduction in fruit load and size in 'Valencia' orange trees in AZ (Hilgeman and Sharp 1970).
- No reduction in yield and chemical characteristics of lemon fruit in Spain (Domingo et al. 1996).

OBJECTIVES

- 1. Evaluate host-plant factors utilized by adult GWSS as long-range cues to locate feeding and ovipositional hosts.
 - Determine preference for surplus-irrigated citrus
 - Determine level of water deficit at which GWSS disperse
 - Determine if fertilizer amendment affects preference
- 2. Investigated the effects of continuous deficit irrigation regimes in citrus trees on the population dynamics and movement of GWSS.







RESULTS (2005 and 2006)

Plant and microclimate conditions:

- Water potential
- Leaf surface temperature
- Canopy temperature and humidity
- Soil moisture
- Yield and sugar concentration in fruits

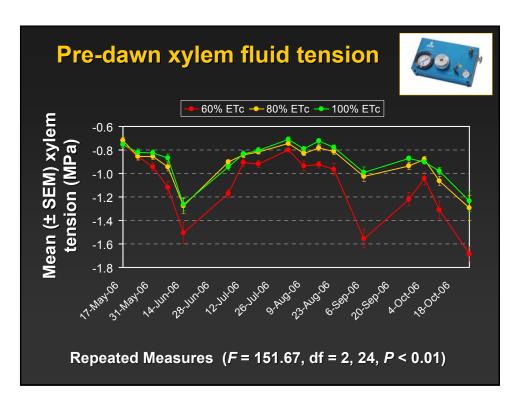
- Homalodisca vitripennis (GWSS)
- Homalodisca liturata (STSS)
- Sophonia rufofascia (Two-spotted leafhopper)
- Natural enemies

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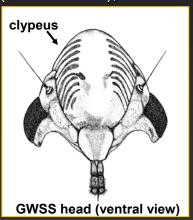
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Feeding preferences of GWSS are largely determined by differences in xylem nutrient content...

- 1) Among plant species (Brodbeck et al. 1990, Bi et al. 2005, Andersen et al. 2005),
- 2) Between young and old plants (Bi et al. 2007),
- 3) Can be adjusted to diurnal changes in xylem chemistry (Brodbeck et al., 1993).

Xylem-fluid tension may override the chemical correlations at high tensions (Andersen et al. 1992)

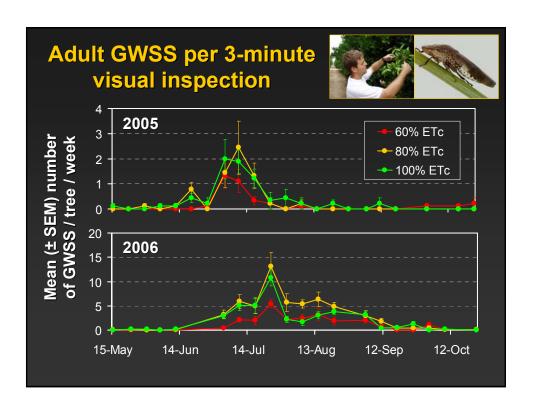


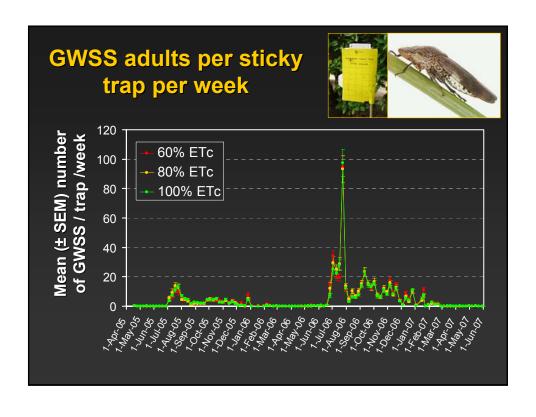
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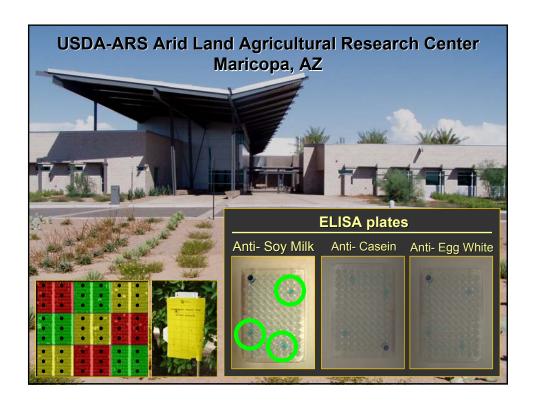
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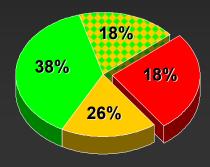






(2006 Season) Total number of GWSS adults caught on 18 sticky traps per irrigation treatment from 06-27-2006 to 10-02-2006.

Irrigation treatments	Total numbers of GWSS					
	Captured	Tested with ELISA	Negative (no markers found)	Positive for protein-marker		
60% ET _c	5212	2760	1947	813		
80% ET _c	5490	3098	1906	1192		
100% ET _c	5216	2754	1928	826		



- Marked with Whole Milk (60% ETc)
- Marked with Egg white (80% ETc)
- Marked with Soy Milk (100% ETc)
- Egg white and soy milk (80% and 100% ETc)

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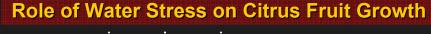




Number of oranges harvested across fruit grade categories ranging from the highest (Sunkist) to lowest quality (discarded)

2007

Treat.	Fruits per ha (x10 ⁵)	Fruit grade (Number of fruits x 10 ⁵)			
		Sunkist (sizes 88 to 180)	Choice (sizes 88 to 180)	Juice	Discarded
60% ET _c	1.13 ± 0.16 b	0.16 ± 0.04 b	$0.13 \pm 0.02 b$	$0.83 \pm 0.13 b$	$0.00 \pm 0.00 b$
80% ET _c	2.24 ± 0.17 a	0.38 ± 0.05 a	0.37 ± 0.05 a	1.47 ± 0.08 a	0.02 ± 0.00 a
100% ET _c	2.33 ± 0.22 a	0.48 ± 0.13 a	0.39 ± 0.07 a	1.42 ± 0.08 a	0.03 ± 0.01 a
F _{value} =	24.83	12.86	8.12	12.86	8.12
P _{value} =	< 0.001	< 0.001	0.002	< 0.001	0.002
df =	2,20	2,20	2,20	2,20	2,20





No reduction in gross revenue with <u>regulated deficit irrigation</u>

50% reduction in yield with continuous deficit irrigation (60% ETc)

SUMMARY

- Trees irrigated with 60% ET_c had warmer leaves and higher water potential.
- GWSS population density was reduced by 50 to 67% in severely water stressed plots (60% ET_c) when compared with moderately water stressed plots (80% ET_c).
- Total number of oranges and numbers of oranges across fruit grade categories was reduced by 50% in trees maintained under severe deficit irrigation (60% ET_c).
- Settling preference in cage studies supports the hypothesis that GWSS disperse from water-deficient plants toward fullyirrigated plants in the field.

CONCLUSION

Irrigation practices can impact GWSS population density and movement, and may, therefore:

- help explain vector movement patterns in agricultural systems
- affect the epidemiology of *X. fastidiosa* diseases
- potentially be manipulated to help manage
 X. fastidiosa disease outbreaks

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Russell Groves Lynn Morrison
James Hagler Tom Ortega
Robert Luck Paul Flores

Kent M. Daane



Settling and oviposition preference were studied on potted 'Washington navel' orange and 'Haas' avocado in cage choice tests, and feeding activity was estimated via excreta produced by insects confined on stems or branches.

The insects settled, oviposited, and fed significantly more on surplus-irrigated plants than on plants under moderate continuous deficit irrigation. Plants under gradual deficit irrigation (GDI) (drought) became less preferred after 3 d and 7 d in avocado and citrus, respectively.

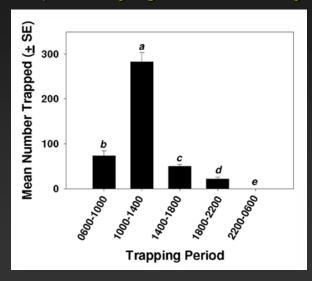
Evolutionary Ecology 1997, 11, 419-437

Why are there no small species among xylem-sucking insects?

VOJTECH NOVOTNY1* and MICHAEL R. WILSON2

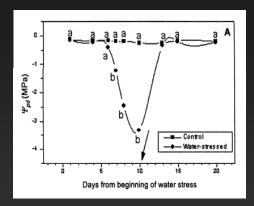
¹ Institute of Entomology, Czech Academy of Sciences and Foculty of Biological Sciences, University of South Bohemia Brastowska 31, 370 05 Cecke Budgiovice, Czech Republic ² Oppartment of Zoology, National Massem of Water, Catalays Park, Cardiff CF1 3NP, UK

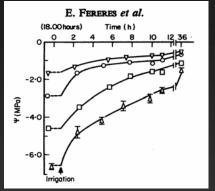
Mean number of GWSS trapped on yellow sticky traps at varying times of the day



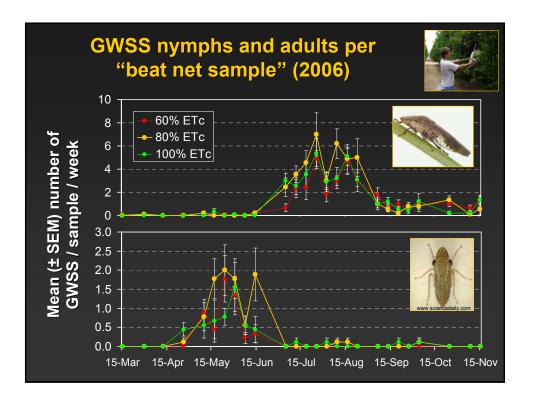
Blackmer et al. 2006. Environ. Entomol. 35: 1617-1625.

Recovery of water potential following irrigation



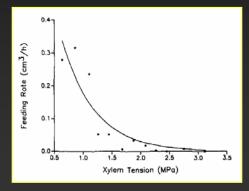


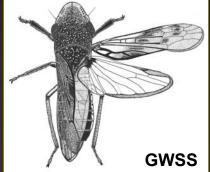
Citrus trees have the ability to fully recover from severe water stress (Fereres et al. 1979, Medina et al. 1999).



...xylem tension may override the chemical correlation at high tensions (> -1.5 MPa).

"Feeding rate on water stressed crape myrtle during midday was associated with <u>xylem tension</u>, and not concentration of chemical variables."





Andersen et al. 1992. J. Insect Physiol. 38: 611-622

Scale lysimeter system - control and monitor delivery of irrigation and fertigation Host Preference Tests 1. Continuous-deficit irrigation (CDI). Treatments: Surplus-irrigated (100% I_c) vs. deficit-irrigated (25% of I_c) plant. 2. Gradual-deficit irrigation (GDI). Treatments: Surplus-irrigated vs. non-irrigated plant. Monitored adult GWSS settling, feeding, and ovipositional behaviors. Nadel et al.

